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JOHN MICHELS, Editor.

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SATURDAY, DECEMBER 10, 1881.

SIR—On the evening of November 24, I noticed that the spectrum of the star DM. $+36°$ 3987 has a bright band in the blue. The star, accordingly, belongs to the small class of objects which comprises Rayet's stars in Cygnus (near this one) and Oeltzen 17681, discovered here in 1880.

On November 25 I found a small planetary nebula, undistinguishable from a very faint star by the ordinary eye-piece, bnt detected by the character of its spectrum. Its place for 1880 is in R.A. $20^h\ 6^m\ 26^s.4$, declination $+37°\ 3'\ 25''$. It follows W. xx 200 eight seconds, three minutes of arc farther south, and is followed respectively $2^s.6$ and $2^s.3$ by two faint stars north $37''$ and south $20''$ of the nebula.

HARVARD COLLEGE OBSERVATORY,
CAMBRIDGE, *December* 1, 1881.

EDWARD C. PICKERING.

SHALER AND DAVIS' "GLACIERS."[1]

By W. J. McGEE.

I. Introduction.—The extensive superficial modification of the globe accomplished through the agency of water in its three states of aggregation has been rendered possible by certain properties peculiar to this substance, chiefly (1) its powers of assuming the several forms of solid, liquid, and vapor within the narrow range of terrestrial temperature, (2) its enormous capacity for heat, and (3) its power of dissolving other substances.

The temperature of the earth's surface is indeed largely determined by the aqueous vapor contained in the atmosphere; for if it were not for this vapor the solar energy falling upon the earth would be radiated away almost as quickly as received, and could exercise but little influence upon temperature. The narrow range of terrestrial temperature since the beginning of the organic record attests the enormous capacity and marvelous delicacy of this temperature—equalizing agent, for within the limited bounds of the space separating earth and sun, the temperature varies from a hundred thousand degrees above to two hundred and fifty degrees below the Fahrenheit zero; though accidents in this adjustment are attested by the traces of successive ice periods in the geological history of the globe. The influence of liquid water in producing the various phases assumed by the earth's surface, during geological time has long been the subject of study; but it is only within the last forty years that the newly commensurate influence of ice has been detected.

II. *The existing glaciers of the earth.*—The most accessible of the existing glaciers are those of the Swiss Alps; and the best route for the student to pursue in entering this region is to pass up the valley of the Rhone.

Here, aside from the more obscure evidence of the former great extension of the glaciers, the various works of ice-action became constantly fresher in ascending the river until they disappear beneath the wall of ice constituting the terminal portion of the glacier. At the foot of this ice wall is an irregular mass of stones and earth—the *terminal moraine*—lying across the valley, cut in twain by the muddy stream emerging from a cavern in the basal portion of the glacier; and the ice itself is gullied by tiny rills and soiled with sand and dirt, and hardened with pebbles and rock fragments, which from time to time roll down its steep front, to the morainal heap below. When the glacier shrinks for several successive seasons, as occurs when the weather is unusually dry and warm, the stream flowing from it becomes a torrent, and the moraine may be separated from the ice front by a belt of striated and polished rock, but sparsely covered with coarse *debris*; but when the ice advances for a number of years the stream dwindles, and the sheet of earth and stones is pushed forward and crumpled up into a mighty embankment, rising into a range of irregular hillocks. Many such ridges attest the various periods of temporary advance in the history of most of the secularly retreating glaciers. On ascending the ice stream itself, the superficial rock-fragments, pebbles, and earth are found to lie mainly in parallel bands, or *medial moraines*; and on tracing these to their origin, each is seen to consist of the two lines of matter constantly tumbling down the valley sides or *lateral moraines* which are brought into contact whenever two glaciers meet and merge into one. Thus the number of branches uniting to form any glacier can be determined from the number of parallel bands on its surface. The ice-stream occupies a crooked and irregular valley, the rate of its motion varying with the declivity, regularity, and width of the channel, just as does that of liquid rivers; though wherever there are considerable irregularities in the channel the strain produces cracks and fissures which gradually widen and form *crevasses*, or even, where there is a sudden increase in declivity, separates the ice into a mass of irregular pyramidal blocks, or *seracs*; but when a more uniform stretch of gentle slope is reached the seracs re-unite, and the crevasses close, transforming the fragmentary mass again into a solid,

[1] "Illustrations of the earth's surface. Glaciers; by Nathaniel Southgate Shaler, professor of Paliontology, and William Morris Davis, instructor in Geology, in Harvard University, Boston. James R. Osgood & Co., 1881." Very large 4°, pp. i—vi and 1-198, pl. i—xxv and one unnumbered, with twenty-five unnumbered leaves discriptive of plates.

homogeneous whole. The channel is rarely so regular as to allow the ice to be altogether free from crevasses, however. Such fissures are invariably at right angles to the line of greatest tension, and greatly facilitate melting by increasing the exposed surface; and when the rills formed by superficial melting flow into them they may be converted into cylindrical shafts, or *moulins*, extending to the base of the ice. Thus both crevasses and moulins remain practically stationary, or rather, when either has passed beyond the obstruction or irregularity of the channel which produced it, it gradually closes, and another forms in the same place, with respect to the valley and not to the moving ice, as that which it originally occupied. Aside from the longitudinal medial moraines the surface of the ice is often indistinctly marked by depressed transverse bands within which wind-blown sand or dust accumulates (known as *dirt-bands*); which bands curve downward medially more and more toward the debouchure of the glacier, and thus attest the differential motion of the various parts of the ice-stream. There are, moreover, occasional scattered blocks of stone and small pebbles lying upon the surface of the ice. The larger blocks prevent superficial melting of the ice on which they rest, and hence become apparently lifted on columns of ice, forming *glacier-tables*, which sometimes reach a height of some feet; while the smaller pebbles, on the other hand, facilitate melting, and thus gradually sink into miniature wells perhaps several inches in depth.

Glaciers of the alpine type are supplied by the perpetual snows accumulating in the elevated valleys and plains intervening between the highest peaks. Over these snowfields—the *névé* or *firn*—the snow is generally granular and contains much air, especially near the surface; though where it is thick its basal portions may approximate true ice in structure. It is only when the névé passes over the considerable declivity generally separating the snow-field from the ice-stream proper, and descends below the snow-line, however, that it becomes compacted, deprived of its air, and diminished in volume, so as to constitute a veritable glacier. A glacial area may accordingly be divided into two distinct regions on this basis alone;—the névé, the locality of no melting but of constant addition; and the glacier proper, the locality of constant decrease. In polar regions the glacial phenomena are more varied. Thus, in Greenland, the transition may be observed from glaciers of the characteristic alpine type to those of the characteristic polar type, in which the snow-line is at the sea level and the ice is essentially identical with the Swiss névé, though of vastly greater thickness. It is only slow-moving glaciers of the polar type that give origin to ice-bergs—the terminal portion extending into the sea "until the buoyancy of the ice causes a mass to break away from its attachments, rise to the surface, and float away, (p. 28,) scattering the debris frozen to its base over the sea-bottom as it gradually melts; for the bergs, as the névé of which they are formed, are generally destitute of superficial accumulations of earth and stones.

Since in the circumpolar regions the snow-line descends to the sea-level, the ice of winter may not be melted during the succeeding summer, but may remain *in situ* for years or ages, as in the paleocrystic sea seen by Nares. Now such a sea might be itself overspread with snow to such a depth as to depress the ice to the sea-bottom and to convert the whole mass into névé similar to that of northern Greenland, or into a true continental glacier. Indeed,—"it seems probable that the so-called antoretic continent is nothing but an immense sheet of ice such as this paleocrystic sea would become if it were to increase in depth until it fastened on the bottom of the sea." (p. 31.)

III. *Distribution of the existing glacier.*—In the Scandinavian mountains there are the large snow-field in the gostedal highland with many scattered glaciers of considerable interest, and, in lat. 70°, a vast snow-field with an immense ice-stream descending to the sea level; while on the opposite side of Russia the Ural range is without glaciers. In the Pyrenees the glaciers are much shrunken, and mainly confined to moist northern slopes, though about one hundred in number. In the Alps there are over a thousand glaciers, occupying, with the névé, about one-seventh of the mountainous alpine region. Eastward there are no glaciers until the Caucasus is reached, where a considerable snowy range, with ice-streams on both slopes, is found. A few scattered glaciers are known in Asia Minor, one in Persia (on the volcano Demarend,) and many on Hindu Kush; though these have been but imperfectly described. In the Himalayas the glaciers are of remarkable size and extent, though as yet but partially known. In the Southern Alps of New Zealand the glaciers are also of considerable extent and of great interest. On the western hemisphere glaciers occur along the western border of South America as far north as Upper Chili, where they mainly disappear, and are but meagerly represented along the Andes and Cordilleras until Oregon and Washington Territory are reached. Those occurring within the United States are of little prominence, however; but they increase in size and number northward, until at Mount St. Elias the ice reaches the sea level. In both Arctic and Antarctic regions there are also immense bodies of moving ice or névé, constituting glaciers of the polar type.

It thus appears that glaciers are mainly confined (*a*) to regions of great cold and considerable precipitation, (*b*) to mountain ranges along western coasts outside of the trade-wind zones in regions of heavy and frequent precipitation, and (*c*) to interior ranges of great height and considerable snow-fall; while (*a*) broad arid areas—even though "the ground is frozen to the depth of several hundred feet" (p. 36),—(*b*) interior ranges of limited snow-fall, and (*c*) regions having a hot and dry summer, are generally free from glaciers. The essential conditions for glaciation are hence, 1st., cold of considerable intensity; 2nd., considerable snow-fall; and 3rd., the absence of a dry season of sufficient length to melt the winters' snow.

IV. *Distribution of ancient glaciers.*—"The most remarkable fact that has been discovered by geologists during this century is, that at various times in the earth's history the glaciers, which now cover but a very small space on the earth's surface, certainly not over about one hundreth of its area of land, have been extended until they occupied a very large part of land and sea "(p. 38)." The glacial records are, however, so ephemeral that none save the last ice-period can ever be well known to us. During this period the accumulation of ice was most extensive in regions where glaciers yet prevail, or where the various meteorological conditions at least approach those which existing ice-fields indicate to be essential for glaciation, as in the Alps, the Pyrenees, and Scandinavia, over northern Europe, and in the Himalayas and New Zealand, on the eastern hemisphere; and over much of the northern portion of North America and a lesser area in the southern extremity of South America as well as isolated localities along the Andes and Cordilleras, in the western hemisphere. Over the plains of Switzerland an ice-sheet more than 4,000 feet thick swept its debris to the flanks of the Jura, a hundred miles away; but on the northern slope of the Alps the extension was less. Here the direction of motion was everywhere determined or at least modified by local topographical features. In the Pyrenees, the Appenines, the volcanic mountains of central France, and the Jura, in the Vosges, and in Corsica, the accumulation of ice was little more than the development of an extensive system of local glaciers; and north of the Alps there is little evidence of glaciation within inland Europe. The most complete testimony concerning European glaciation in the Quaternary, is furnished by Scandinavia and Great Britain. "Stretching from Scandinavia across the North

Sea, which it must have nearly closed, the North Europe glaciers extended over Scotland, all the north of England, and probably all of Ireland. On the north its limits were perhaps the polar ice itself, and in the west the deeper waters of the Atlantic. The southern limit of this ice-sheet was in the south-central part of England" (p. 40). This was probably "the southern edge of the polar ice tops [ice cap?] rather than a local system of glacial sheets" (p. 40). In North America the accumulation of ice was still more extensive, and of somewhat different character; "here the ice lay as a continuous mass, stretching down from the polar regions to the central parts of the continent, overlapping the shores for a great distance to the south along the Atlantic and Pacific coasts, and giving a continuous though irregular ice front across the land from sea to sea" (p. 41). The terminus of this sheet is yet marked by moraines as constituting the Banks of Newfoundland, George's Banks, Cape Cod, Martha's Vineyard, and Block and Long Islands, and extending thence across central New Jersey, and south as far as Washington. The attenuated margin left less distinct traces of its existence in the hills of southern Virginia, and thence into the higher Appalachians in North Carolina, whence it returned hugging the western mountain slope, and extending through West Virginia, crossing the Ohio river near the mouth of the Kanawha. Thence the southern edge of the ice skirted the north shore of the Ohio to Cincinnati, near which place it sent a lobe across the river a few miles into Kentucky. "West of Cincinnati the front of the ice sheet inclined rapidly to the north-west, and becomes hard to trace. It probably passed somewhat south of Chicago, through Iowa, and thence through Minnesota, following near the line of the Missouri to the Rocky Mountains" (p. 42). In the Cordilleras the ice was mainly confined to the higher mountains, and probably partook of the character of local or alpine glaciers within the limits of the United States; while north of our domain "we know little of its distribution" (p. 42). "There can be little doubt that the ice sheet was continuous from its southern face to the poles during the depths of the last ice time. *** This glaciated region of North America includes more than half the continent; in fact over two thirds of its surface felt the weight of the ice during the last geological period, and works its work in the existing geography" (p. 44). The thickness of the ice is not definitely known except in the vicinity of Mt. Washington, where it exceeded a mile. In South America it is probable that continental ice never extended north of the Rio de la Plata over the plains, nor beyond the Chilian coast on the Andes.

V. *The work of the glacial time.*—Water, whether liquid or solid, is a most efficient agent of erosion; but the mode of action of the two forms is quite different. Liquid water itself operates in a two-fold manner: 1st, as a chemical agent, penetrating the earth and disorganizing its constituents, forming caverns, mineral veins, and residuary products; and 2nd, as a mechanical agent, loosening, removing, and comminuting the rocky particles, and finally bearing them to the sea to form new lands; but in the solid form only mechanical activity is manifested. There is, first, the enormous weight of the glacier (more than a ton per square inch beneath a glacier a mile in thickness), enough in itself to comminute rocks not strongly coherent and well supported laterally; there is then the abrading action of this tremendous weight dragged slowly forward—the ice being armed with fragments of rock frozen into its mass; and there is finally the corroding action of the sub-glacial streams (sometimes, perhaps, under great hydrostatic pressure) which constantly bear away the finer detritus and prevent the clogging of the grinding faces of the glacial mill. The rapidity of operation of these forces must be almost beyond conception. Even in the diminutive Alpine glaciers the sub-glacial streamlets are so fully charged with impalpable mud as to carry away more material in a few days than is moved by a sub-aerial stream of like size in a year. Now, since the erosive action of the ice is proportional to its thickness, and since, moreover, this action is most effectively supplemented by sub-glacial streams in valleys, it is manifest that the tendency of glaciation is to increase the depth of existing depressions, and thus intensify topographical irregularities. Accordingly, glaciated regions are characterized by deep bays and fords along the coast line, V shaped valleys intersecting mountainous areas, and elongated basin-like ponds and lakes dotting more uniform surfaces—the longer axes coinciding with the direction of ice-motion; while at the same time abrupt peaks and irregular knobs are replaced by gracefully rounded swells with trains of fragments to the leeward. Since the average rate of glacial erosion is so high (it was a foot in a thousand years, or more than seven times as rapid as sub-aerial erosion in New England) it would appear that important geographical changes ought to follow the visitation of an ice-sheet, not only by the carrying out of a new series of hills and dales, but by heaping up of piles of earth and stones of such magnitude as to necessitate the development of a new drainage-system; and accordingly just such geographical vicissitudes are abundantly attested in north-eastern United States and elsewhere.

The most conspicous evidence of glacial action is the mantle of *drift* occupying areas formerly overspread by ice. This drift consists of the materials torn up and indiscriminately intermingled by the glacier, and is generally a confused, unstratified mass of stones of all sizes and shapes, generally much worn, cemented together by sand and clay. It is sometimes heaped up in irregular moraines; some of which doubtless mark the lines of greatest extension of the ice, while others probably indicate temporary pauses or re-advances in its secular retreat. Along the coast this deposit has been re-arranged superficially by wave and tide, and has afforded material for immense accumulations of *terrace drift*; the unmodified basal portion being sometimes left in the form of gracefully arched *lenticular hills* of elliptical outline, the longer axis extending in the direction of motion of the ice. In regions not submerged at the close of the ice-period the upper portion of the drift has been modified by the action of running water and of vegetal growth. The moving water was rendered effective during the retreat of the ice, not so much by the increased volume to be borne sea-ward as by the imperfection of the nascent drainage system. The valleys were clogged with glacial waste, forming hosts of pools and lakelets which burst from time to time and shifted the hetrogeneous mass here and there in a series of pygmy debacles. The terraces of this period along the Connecticut river and its tributaries contain scores of cubic miles of drift thus re-arranged, and indicate by their altitude that much more material than that now remaining has been removed. Among the minor drift phenomena are the isolated hills and greatly elongated ridges of sand, gravel, or stratified clay, denominated *aasar*, *kames*, or *eskers*. "No sufficient explanation has yet been given of their origin" (p. 66). In the best instance known the deposit is probably a central terminal moraine, deposited in a valley of uniform slope, by a retreating local glacier. Other examples, however, appear to be not morainal; and it may be long before we understand the method of their formation" (p. 68).

VI. *The origin and nature of glacial periods.*—The earliest of the several hypotheses which have been put forth to explain the cause of the glacial period referred the phenomenon to the secular refrigeration of the globe; but the hypothesis is untenable, since it does not contemplate the several successive transitions from warmth to cold. A second hypothesis is that of Poisson, who suggested that in the proper motion of the solar system it might from time to time come into such proximity to, or recede to such a distance from, neighboring stellar bodies

as to materially affect the temperature of the planets. "This seemed a very reasonable view, and, indeed, it cannot well be questioned that if one-half of the heat that reaches the earth's surface comes from the stars, it is likely to be warmer near an aggregation of three suns than it is where we are now" (p. 70); but astronomical considerations show that the hypothesis as a whole is untenable. Next is the view of Lyell, who attributed climatal oscillations to changes to the relative position of sea and land; but the view is open to the sweeping objection that the formulated cause would produce opposite effects from those which the hypothesis attempts to explain. The effect of minor geographical alterations on climate cannot, however be denied. Tyndall and others have shown that slight variations in the quantity of aqueous vapor, carbonic acid, or some other substances contained in the atmosphere must materially effect terrestrial temperature; but any such variations which we are justified in assuming would probably be inadequate to alone explain the phenomena of the glacial period. The next hypothesis is that of Croll, who, recognizing the fact that the "orbit of the earth around the sun is not circular, as it might be if the earth were the only companion of the sun in the solar system" (p. 73), points out (1) that during periods of high eccentricity in the terrestrial orbit the precession of the equinoxes may lead to a considerable variation in the length of the seasons, and hence to an accumulation of snow and ice in the hemisphere having the long winter and the short summer; and (2) that when such accumulation was in the northern hemisphere the effect upon the trade winds would be such as to deflect the Gulf Stream feeders to the south of Cape St. Roque and thence into the Antarctic regions, and thus further refrigerate the northern hemisphere. The hypothesis is the most important yet enunciated, though it presents certain difficulties. Other views are that changes in the earth's axis of rotation, or in the obliquity of the ecliptic may materially affect the temperature of the globe; but these views can be mathematically proven to be inadequate. Yet another hypothesis is that which attributes the phenomenon to variations in solar emission, and which "seems a most likely cause of glacial conditions" (p. 90). Less important hypothetical causes are minor geographical changes affecting aërial or marine currents—for instance, the comparatively recent elevation of Sahara, and the probable late Quaternary depression and subsequent re-elevation of Alaska and Kamchatka; but it is clear that no conceivable array of geographical changes can explain the origin of the last glacial epoch.

(To be continued.)

THE HIPPOPOTAMUS.—Dr. Henry C. Chapman, of Philadelphia, has recently devoted much attention to the anatomy of the Hippopotamus, and has read an elaborate paper before the Academy of Natural Sciences, of Philadelphia. We notice that he draws the following conclusions: "beginning with the pig, we pass by an easy transition to the Piccary, which leads to the Hippopotamus, and thence in diversing lines to the Ruminantia on the one hand and the Manatee on the other. Paleontologists have not discovered a form which bridges over the gap between the Hippopotamus and the Manatee, but it will be remembered that certain fossil bones, considered by Cuvier to have belonged to an extinct species of Hippopotamus, *H. Medius*, are regarded by Gervais as the remains of the *Halithorerium fossile*, an extinct Sirenean of which order the Manatee is a living representative." Dr. Chapman adds further on, "I do not mean to imply that the Manatee has necessarily descended from the Hippopotamus," but he considers that "there is some generic connection between them."

PROF. C. V. RILEY believes that the diminished virulency of Phylloxera in sandy soils is due to its mechanical action on the insect, his own experiments showing the difficulty such insects meet with in soils of a sandy nature.

NEW YORK ACADEMY OF SCIENCES.

November 21, 1881.

SECTION OF BIOLOGY.

The President, DR. J. S. NEWBERRY, in the Chair.

Thirty one persons present.

The following paper was read by Prof. LOUIS ELSBERG, M. D.

ON THE CELL-DOCTRINE AND THE BIOPLASSON-DOCTRINE.

Mr. President and Fellows of the Academy, Ladies and Gentlemen.—Last May, at the meeting of the American Laryngological Association, I rendered account of some histological investigations of the cartilages of the larynx, a report of which is published in the October Number of the *Archives of Laryngology*. As the structure of hyaline cartilage has an important bearing on my subject of this evening, I crave your attention for a few minutes for a brief review of those investigations.

You know the larynx or voice-box consists of a framework of cartilage or gristle. This cartilage is called hyaline or glasslike, because it is opalescent and looks like milk-glass. Having frequently been examined under the microscope, it has always been looked upon as one of the simplest tissues, namely, as being composed of a hard matrix or basis-substance, in which are imbedded a number of small softer bodies. These softer bodies, the cartilage corpuscles, have since the establishment of the cell-doctrine been called cartilage cells. As these cells were known to be alive, the question which scientific men have had to try to answer was: how can they obtain nutrition, being isolated and enclosed in the firm, unyielding cartilage basis-substance?

Without going too much into details, I may say that it was assumed that nourishing liquid reaches the corpuscle either by imbibition and diffusion or else through canals or fissures in the homogeneous basis-substance. The idea of the existence of "juice-channels" originates with VON RECKLINGHAUSEN, although others before him had spoken of "pores" through which nutrient juices might pass. BUDGE and others believe in the presence of regular canals for this purpose, while TILLMANNS and many with him believe that hyaline basis-substance consists of fine fibrils so closely held together by a cement-substance that the mass appears to be homogeneous; it is supposed by some that this inter-fibrillar cement-substance is a viscous, soft material which permits the imbibition of nutrient liquid; by some that there are clefts or fissures, and by others that there are regular channels tunnelled in this cement-substance. On the other hand, HEITZMANN, SPINA, FLESCH and others have found that there are cilia-like offshoots or prolongations of the substance of the corpuscle penetrating into the basis-substance. Such prolongations might carry on nutrition. I have had the opportunity 6 or 7 years ago to repeat Heitzmann's observations under his own eyes and with his assistance; but the results as to their correctness at which I arrived, were to the best of my belief uninfluenced by him.

My own recent investigations have not only confirmed the existence of such offshoots and shown that they form an inter-connected reticulum or network throughout the basis-substance, but I have discovered in several specimens, small lumps in this network which, by all the tests applied to them, were proved to be lumps of living matter in various stages of existence! These investigations are illustrated by the accompanying drawings viz.

Fig. 1. exhibits the appearance of a longitudinal section of the plate of the thyroid cartilage with an amplification of 100 diam.

Fig. 2. shows offshoots from the cartilage corpuscles and the network in the basis-substance with more or less large granules interwoven, as it were, in the network.

Fig. 3. shows granules of various sizes in the basis-substance with lower power of the microscope, which granules are seen with higher powers to be connected with the network of living matter, as shown by fig. 4.

Doubt as to the interpretation is impossible: instead of being a mass of basis-substance in which a number of cartilage corpuscles are imbedded, hyaline cartilage is a filigree of living matter, in the meshes of which a number of blocks of basis-substance are imbedded.

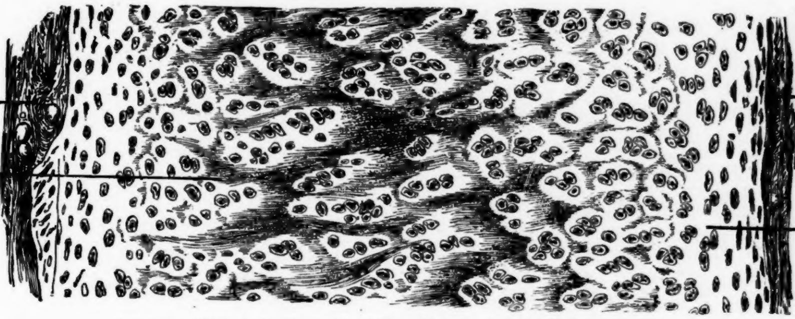


FIGURE 1.—Plate of the Thyroid Cartilage of Adult. Longitudinal Section x 100.

A. Perichrondrium towards the mucus membrane.
B. Perichrondrium toward the skin.
F. Fibrous portion of cartilage in the centre.
H. Hyaline portion, on either side, near the perichondrium.

Now, for our subject proper.

The founder of the Cell-Doctrine, Schwann, has recorded in the Introduction to his great work published in 1839 that the doctrine was based to a large extent upon investigation of the constitution of cartilage. After Johannes Müller had described cartilage-corpuscles that were hollow, and Gurlt had spoken of some as vesicles,—when Schwann had succeeded, as he thought, "in actually

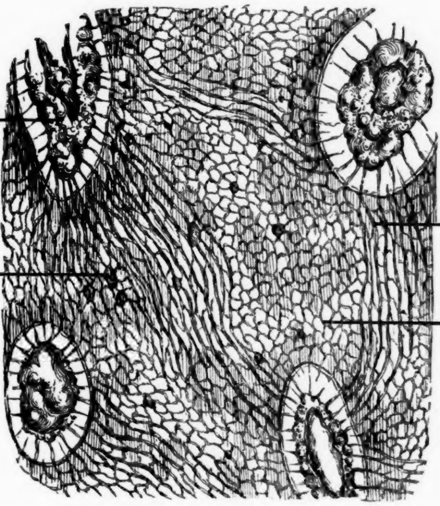


FIGURE 2.—Thyroid Cartilage of Adult, kept in strong Alcohol. Horizontal Section x 1200.

C. Shrivelled cartilage corpuscle.
O. Longitudinal off-shoots.
R. Reticulum in basis-substance.
G. Granules of living matter.

observing the proper wall of the cartilage corpuscles, first in the branchial cartilages of the frog's larvæ and subsequently also in the fish," he was led by these and other researches to conjecture "that the cellular formation might be a widely extended, perhaps a universal, principle for the formation of organic substances." And just as the study of cartilages has led to the cell-doctrine, which at the time of its establishment was a great advance in biological science, so the further study of cartilage has supplied the basis for a generalization which is a further development, and must take the place of the cell-doctrine. This is Heitzmann's doctrine of living matter, or, as I have named it, the ***bioplasson-doctrine.***

When the term "cell" was introduced in 1838 and 1839, by Schleiden and Schwann, it was believed that on ultimate morphological analysis every plant and every animal would be found to consist of a number of minute vesicles or sacs, enclosing liquid contents in which is suspended a more solid body, the nucleus. For fully twenty years this idea has been known to be erroneous. In fact, *Goodsir*, nearly *forty* years ago—only a few years that is, after Schwann had established the cell-doctrine and attributed the vital power to the cell-membrane, I say,

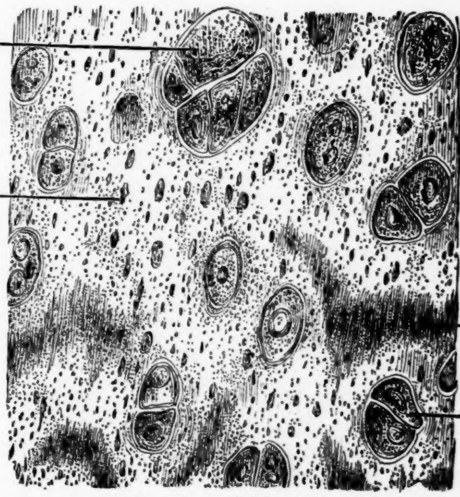


FIGURE 3.—Thyroid Cartilage of Adult. Horizontal Section x 600.

C. Cartilage corpuscle.
F. Fibrous portion of cartilage.
G. Granules of living matter.

nearly forty years ago Goodsir had experimentally determined that the seat of the vital process of secretion is ***not*** in the vesicle as such, but in the so-called cell contents; Naegeli, in 1845, and Alexander Braun, in 1851, had also shown the cell-wall to be comparatively unimportant; and in 1857 Leydig had declared the "cell" to consist only of a soft substance enclosing a nucleus. Certainly, twenty years ago it was proved beyond dispute by Max

Schultze, Beale, Hæckel, and others, that what was called a "cell" was not a vesicle, but essentially a jelly-like lump of living matter characterized by the presence of a nucleus; soon after, Robin, Brücke, Kühne, Stricker, and others, conclusively showed that not even a nucleus is an essential constituent of an elementary organism; and, biologists were compelled to transfer the power of manifesting vital properties to "living matter" instead of restricting this power to any definite form-element. As long ago as in 1861, Brücke proposed to discontinue the use of the word "cell" as being a misnomer and misleading, and offered as a substitute the expression "elementary organism." Beale proposed, instead, the term "bioplast" to designate any definite mass of living matter, and Hæckel the term "plastid." From the latter I devised the word "plastidule" as synonymous with ultimate molecule of the substance of living matter. Elementary living matter is called with Dujardin "sarcode," or with Von Mohl "protoplasm," or with Beale "bioplasm," or, still better (because it is a designation etymologically more nearly meaning living, forming matter), "bioplasson." Of these four synonymous terms "protoplasm" is the one best known; but has been used in other senses, as well as to designate, merely, elementary living matter. I therefore think that "bioplasson" is to be preferred. Of course, *dead* bioplasson is a contradiction in terms: bioplasson deprived of vitality is no longer bioplasson at all, but merely the chemical remains of what *once was* bioplasson. If this be remembered, there will be no confusion, even if the word be used in describing tissues, etc., after death. According to Drysdale, Dr. John Fletcher of Edinburgh was the first, who clearly arrived at the conclusion that "it is only in virtue of a specially living matter, universally diffused and intimately interwoven with its texture, that any tissue or part possesses vitality."

As Fletcher's work was published in 1835, several years before even the establishment of the cell-doctrine, we cannot but agree so far with Drysdale as to say that Fletcher has framed a "hypothesis of the anatomical nature of the living matter which anticipates in a remarkable manner" its discovery! In 1850, Cohn[1] recognized the protoplasm "as the contractile element, and as what gives to the zoöspore the faculty of altering its figure, without any corresponding change in volume." He concludes that protoplasm "must be regarded as the prime seat of almost all vital activity, but especially of all the motile phenomena in the interior of the cell." In 1853 Huxley[2] said "vitality, (the faculty, that is, of exhibiting definite cycles of change in form and composition), is a property inherent in certain kinds of matter." In 1856 Lord Osborne discovered carmine staining, and distinguished by means of coloring it the living formative matter from the formed material, a means which has borne important fruits in the discovery of Cohnheim's staining of living matter by gold chloride, and in that of Recklinghausen's staining all except living matter by silver nitrate.

In 1858, and in a number of later articles,[3] Max Schultze, by showing that, as had been hypothetically supposed by Unger, the movements of the pseudopodia and the granules are really produced by active contractile movements of the protoplasm, as well as by other observations, contributed much to the establishment of the theory of living matter. Hæckel has also for many years, and in various publications,[4] labored to maintain and extend the same theory, of which he thus expresses himself.[5] "The protoplasm or sarcode theory, that is the theory that this albuminous material is the original active substratum of all vital phenomena may, perhaps, be considered one of the greatest achievements of modern biology, and one of the richest in results." And says Drysdale[6]: "if the grand theory of the one true living matter was, as we have seen, hypothetically advanced by Fletcher, yet the merit of the discovery of the actual anatomical representation of it belongs to *Beale*, in accordance with the usual and right award of the title of discoverer to him alone who demonstrates truths by proof and fact. * * * The cardinal point in the theory of Dr. Beale is not the destruction of the completeness of the cell of Schwann as the elementary unit, for that was already accomplished by others. * * * But that, from the earliest visible speck of germ, up to the last moment of life, in every living thing, plant, animal, and protist, the attribute of life is restricted to one anatomical element alone, and this homogeneous and structureless; while all the rest of the infinite variety of structure and composition, solid and fluid, which make up living beings, is merely passive and lifeless formed material. This distinction into only two

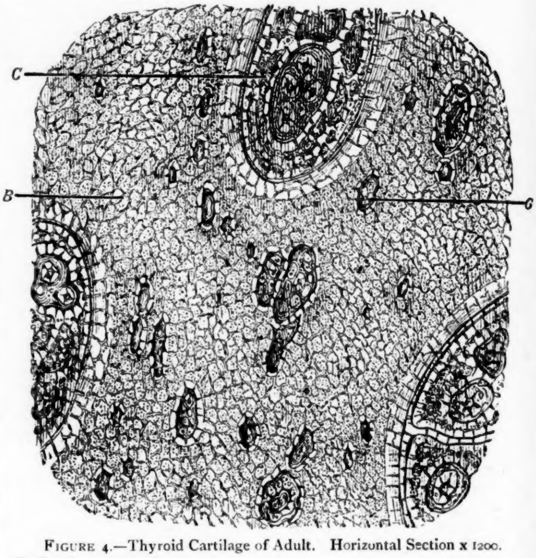


FIGURE 4.—Thyroid Cartilage of Adult. Horizontal Section x 1200.
C. Cartilage corpuscle.
B. Hyaline basis-substance.
G. Granules of living matter.

radically different kinds of matter, viz., the living or germinal matter and the formed or lifeless material, gives the *clue* whereby he clears up the confusion into which the cell-doctrine had fallen, and gives the point of departure for the theory of innate independent life of each part, which the cell-theory had aimed at, but failed to make good. The one true and only living matter—called by Beale germinal matter, or bioplasm—is described as 'always transparent and colorless, and as far as can be ascertained by examination with the highest powers, perfectly structureless; and it exhibits those same characters at every period of its existence.' * * *

The name of bioplasm, continues Drysdale, given by Beale, or protoplasm, as indicating the ideal living matter, cannot be given to any substance displaying rigidity in any degree, nor to anything exhibiting a trace of structure to the finest microscope: nor to any liquid; nor to

[1] "Nachträge zur Naturgeschichte des Protococcus pluvialis." *Nova acta Acad. Leop.-Carol.*, vol., xxii., part i., p. 605.

[2] "Review of the Cell-theory." *British and Foreign Medico-chirurg. Review*, Oct., 1853.

[3] "Ueber innere Bewegungs-Erscheinungen bei Diatomeen," *Müller's Archiv*, 1858, p. 330; "Ueber Cornuspira," *Archiv f. Naturgesch.*, 1860, p. 287; "Ueber Muskelkörperchen und das was man eine Zelle zu nennen habe," *Reichert und Du Bois-Reymond's Archiv*. 1861, p. 1; Das Protoplasma der Rhizopoden und der Pflanzenzellen, Leipzig, 1863.

[4] Monographie der Radiolarien, 1862, pp. 89, 116; "Ueber den Sarcodekörper der Rhizopoden," *Zeitsch. f. Wissensch. Zoölogie*, 1865, p. 342; Generelle Morphologie, vol. i, pp. 269, 289.

[5] Monographie der Moneren," *Jenaische Zeitschft f. Medicin und Naturwissenschaft*, 1868, iv, 1; translation in *Quarterly Journal of Microscopical Science*, London, 1869, vol. ix, p. 223.

[6] *Loc. cit.*, 42, *et seq.*

any substance capable of true solution. Thus, 'nothing that lives is alive in every part,' but as long as any individual part or tissue is properly called living it is only so in virtue of particles of the above-described protoplasm freely distributed among, or interwoven with the textures so closely that there is scarcely any part $\frac{1}{1000}$ of an inch in size but contains its portion of protoplasm. Thus we see realized the hypothesis of Fletcher, that all *living action* is performed *solely* by virtue of portions of irritable or living matter *interwoven* with the *otherwise dead* textures." The objection, however, urged by *Bastian* to Beale is so very pertinent, that it must also find a place here, but I shall not dwell upon other points on which Beale differs from the bioplasson doctrine ; such as, that living matter exhibits the same characters at every period of its existence ; and that it is always perfectly structureless. "It has always appeared to me," says Bastian,[1] "to be a very fundamental objection to Beale's theory, that so many of the most characteristically vital phenomena of the higher animals should take place through the agency of tissues—muscle and nerve, for instance—by far the greater part of the bulk of which would, in accordance with Dr. Beale's view, have to be considered as *dead* and inert."

In 1873, the morphological knowledge of living matter became exact. In that year, Heitzmann discovered the manner in which bioplasson is arranged throughout the body, and announced the fact that what had until then been regarded as *separate form-elements* in a tissue are really *interconnected portions* of living matter ; that not only are there contained *no* isolated unit-masses in any *one* tissue, but *no tissue* in the *whole body* is isolated from the *other* tissues ; and that the only unconnected particles of living matter are the corpuscular elements of liquids, such as blood, sperm, saliva, pus, etc., and so-called wandering corpuscles ; so that, to use his own words: "the animal body as a whole is a connected mass of protoplasma in which, in some part, are imbedded isolated protoplasma-corpuscles and various not-living substances (glue-giving and mucin-containing substances in the widest sense, also fat, pigment-granules, etc.)." This announcement marked the commencement of a new era in biology.

Heitzmann discovered that the living matter as seen in an amœba is *not without structure*, as had, before his accurate investigations, been supposed ; and that its structure, in all cases when developed, is that of a network, in the meshes of which the bioplasson fluid, or the not-contractile, not-living portion of the organism, exists. When there is a nucleus, it is connected by delicate threads with the extranuclear network ; nucleoli and nucleolini inside of the nucleus, as well as granules outside, are portions of living matter : sometimes in lump, sometimes mere points of intersection of the threads constituting the intranuclear and extranuclear living networks, sometimes terminals of section of such threads, as first explained by Eimer,[1] and after him by Klein.[2]

Heitzmann discovered that what is true of the structure of bioplasson in the amœba, where a single small unit-mass of living matter constitutes the entire individual, is true also of the structure of bioplasson of all, even the highest, living organisms.

To be sure much had been previously known regarding protoplasm or living matter, but the knowledge was fragmentary, until Heitzmann demonstrated ***not only***, that membrane, nucleus, nucleolus, granules, and threads *are really* the living contractile matter, but also, 1st, that this matter is arranged in a network, containing in its meshes the non-contractile matter, which is transformed into the various kinds of basis-substance, characterizing the different tissues of the body ; and 2d, that the tissue-masses of bioplasson throughout the whole body are ***interconnected*** by means of fine threads of the ***same*** living matter.

Unless these two facts of Heitzmann's discovery are accepted, there cannot be urged much against the continued use of the word "cell," misnomer though it be. Ranke,[1] after speaking of the "cell-wall," "cell-nucleus," etc., says : "of these component parts of the cell, one or other may be wanting without the totality ceasing to be a cell. The nucleoli, the cell-wall, or the nucleus may be wanting, and yet we must designate the microscopic form a cell, or elementary organism." Drysdale thus comments upon this quotation, viz. : "if any one choose to describe a gun-barrel as a stockless gun without a lock, he is free to do so ; but what good purpose can it serve ? Or is there even any fun in it ? The truth is, this clinging to the mere name of the cell-theory by the Germans seems to arise from a kind of perverted idea of patriotism and of *pietas* toward Schwann and Schleiden." But, I think Tyson[2] has the better of the argument, in saying : "the word "cell" has become so intimately associated with histology, that it is doubtful whether it will ever fall into disuse, nor does it much matter, so long as correct notions of the elementary part are obtained." Now, if *there were any* separate and distinct "elementary part," it certainly would matter little or nothing whether it were called "cell" or by any other name, provided the name be properly defined and agreed upon. It is not against the name but against the idea of any *isolated individualized form-element* that the objection lies. Virchow maintains[1] "that the cell is really the ultimate morphological unit in which there is any manifestation of life, and that we must not transfer the seat of real action to any point beyond the cell." Against this statement nearly every author nowadays protests, and insists that vital power must be transferred from the "cell" to "living matter" ; yet, after all, the disagreement, though ever so strenuously declared, is a mere verbal one : so long as both parties hold that "every higher animal presents itself as a sum of vital unities"—no matter what these unities are called or how defined. Hæckel, one of the most avowed advocates of "the protoplasm or sarcode theory," clings to Virchow's politico-physiological comparison, that every higher organism is like an organized social community or state, in which the individual citizens are represented by the "cells" [no matter how he may define these], each having a certain morphological and physiological autonomy, although on the other hand interdependent and subject to the laws of the whole. Heitzmann's views necessitate the comparison of the body to a machine, such as a watch or a steam-engine, in which, though there are single parts, no part is at all autonomous, but all combine to make up one individual. Even Huxley, the popular champion of protoplasm as the physical basis of life, quite recently delivered an address, before the International Medical Congress in London, August 9, 1881, in which he used the following language : "in fact, the body is a machine of the nature of an army, not of that of a watch, or of a hydraulic apparatus. Of this army, each cell is a soldier," etc., etc. According to Hæckel and Huxley, the body is composed of *colonies* of amœbæ ; according to Heitzmann the body *is one com-*

The Beginnings of Life : being some account of the nature, modes of origin, and transformations of lower organisms. London, 1872, vol. i., p. 155.

[1] "Weitere Nachrichten über den Bau des Zellkerns." *Archiv f. mikrosk. Anatomie*, XIV, 1877, p. 103.

[2] "Observations on the Structure of Cells and Nuclei," *Quarterly Journal of Microscopical Science*, Jan., 1879, p. 128. "The intranuclear as well as the intracellular network having, of course three dimensions, includes fibrils that lie in the two dimensions of the plane of the field of the microscope, as well as fibrils placed vertically to it. The former appear, of course, as fibrils ; but, I should like to ask, as what do the latter appear, *i. e.*, those situated vertically. Clearly as dots, because they are seen endwise ; and for obvious reasons most of them lie in the nodes of the network."

[1] The Cell-Doctrine ; its history and present state. Philadelphia, 1878, p. 128.

[2] "Physiologie, 1872," quoted by Drysdale, *loc. cit.*, p. 104.

[1] Die Cellularpathologie in ihrer Begründung auf physiologische und pathologische Gewebelehre, Berlin, 1858, p. 3. (Translation by Chance, London, 1859, p. 3.)

plex amœba. I am very anxious to really make the difference between the cell theory and the bioplasson theory clear to every one of you. The essential point of the cell theory is, the idea that the body and each tissue of the body, every plant, and every animal, is made up of a number of distinct units, and the essential point of the bioplasson theory is, the idea that all the masses of living matter of each tissue of plants and animals are uninterruptedly connected, and that every tissue is connected with every other tissue by filaments of living matter. To accept Mr. Huxley's comparison, we must imagine that every soldier is indissolubly connected, hand and foot with every neighboring soldier of the solid army!

There is no *better test* of the TRUTH of the bioplasson doctrine than the structure of hyaline cartilage. If hyaline cartilage consisted, as "is generally believed," of "a homogeneous ground substance, in which are closed cavities harboring the corpuscles," [1] the bioplasson doctrine would certainly be erroneous. If it merely contained lymph, or juice-channels, no matter what their character, whether open or closed, whether lined or unlined, whether in "homogeneous basis-substance,' or "between layers of cells," or "in cement-substance," then, too, the bioplasson doctrine would be erroneous.

But the result of my observations, especially those illustrated in figs. 2, 3, and 4, admit of but one interpretation, and that an interpretation favorable to the bioplasson doctrine. It is unnecessary to more than mention that although I have placed on record so few, I have made many different examinations, under many different circumstances, and with varying powers of amplification. I need occupy myself here with only the two fields drawn in figs. 3 and 4, with an amplification of 600 and 1200 respectively. The remarkable specimens from which they are taken show more conclusively than it was ever before shown *what* the structure or constitution of hyaline cartilage *really* IS. I think I have *explained* this sufficiently, but its full significance appears in its *corroboration* of the *bioplasson* doctrine.

To be able to uphold the cell-doctrine, cartilage would have to be, using a homely comparison, like a cake composed of hard dough with raisins. No matter how widely we may extend the definition, to remain within the boundary of the cell-doctrine this metaphor must be applicable. Innumerable painstaking researches have led to various modifications of notions entertained regarding the structure of the two constituents of the cake and their relation to each other. It may be seen by the most recent publications on the subject, that the acceptation of the existence in the dough of cleavage in certain directions, of interlaminary and interfibrillar spaces, and of offshoots, even ramifying prolongations of the raisin-substance, or, at all events, of an ingredient of the raisins, is held to be not incompatible with the cell-doctrine. If, however, we can represent cartilage as a filigree or framework of raisin-substance, in the meshes or interspaces of which framework blocks of dough are imbedded, certainly the fundamental view of the ultimate construction of the tissue is changed, and we are no longer in accord with the cell-doctrine, even though we be inclined to use that term in the widest possible sense. Look for a moment at the two illustrations on the blackboard, as well as at figs. 2, 3, and 4. The upper figure represents a section of cartilage stained with gold chloride. This, as I have already alluded to, stains the living matter and leaves the basis-substance unstained. High powers exhibit the appearance, etc., etc. In regard to a NAME as a *substitute* for the term "*cell,*" I would say that all corpuscular masses may be called, simply, corpuscles—thus we may speak of blood-corpuscles, pus-corpuscles, etc. For all the accumulations of living matter within the ordinary fields of basis-substance, but more especially for those smaller masses which, having as yet developed neither a network structure nor much vacuolation, are still homogeneous, or nearly so—I am quite willing to adopt either the designation of "plastids," proposed by Hæckel, or that of "bioplasts," proposed by Beale. Perhaps it would be well to restrict the word "bioplast" to a small mass of living matter exhibiting no differentiation, and distinguish from it as "plastid" the larger mass showing an interior structure more or less like the fully developed corpuscle. Thus, I would always use the term "plastid" in the place of "cell."

The result of my investigations as to the structure of cartilage is that in this tissue, beyond the possibility of a doubt, the living matter is arranged in the form of a network containing in its meshes the non-contractile matter. How is it with regard to the other proposition of the bioplasson doctrine, viz., that the living matter of the different tissues is interconnected? Examinations with high powers of such a specimen as that represented in fig. 1, showing the perichondrium, of horizontal sections through the larynx, or the neck, with skin and more or less of other tissues included, enable me to answer this question to the effect that fine filaments of living matter pass from one tissue to another in connection with the network of living matter in each. The details of these examinations are reserved for another time! But it has been suggested to me that I ought not to conclude without saying a few words as to the *practical* advantages of the Bioplasson Doctrine over the Cell-Doctrine. Well, *every exact* scientific investigation, even though at first of *theoretical value* only, sooner or later brings with it some practical benefit; and this doctrine of living matter, aside from the satisfaction which the perception of ABSTRACT *truth* grants—lying as it does at the foundation of our knowledge of living things—has advanced their physiology, and pathology at every point! In *Practical Medicine* it has already aided us in so many ways that their merest enumeration would require another hour's lecture. We know that the disposition of living matter is different in different persons, and that in the case of increased supply of food the *reaction* is different in strong and healthy people from that in the sick and weak. Upon this knowledge rests, to-day, the *whole doctrine of pulmonary consumption.* Now, the *amount of living matter* within the same bulk *varies greatly*, both in normal and morbid conditions. A small lump of bioplasson in the urine or expectoration, taken from an individual of *good* constitution, will show a *close* network with coarse granulations, or perhaps be almost *homogeneous*-looking under the microscope—owing to the *large amount* of living matter in the small bulk: while a plastid from a weak, broken down or phthisical person will be finely granular and exhibit a *network with large meshes* on account of the *relatively small amount of living matter* in it. Sometimes we thus from the examination of a *drop of blood* gain an insight into the condition and vital power of the whole individual; sometimes, recognize a disease before it is sufficiently developed to do much harm, and thus come a step nearer to the *highest aim* of the physician:—the *prevention* of disease.

DISCUSSION.

Dr. B. N. Martin remarked on the great value and important bearing of this investigation.

Mr. A. C. Elliot enquired whether the blocks of non-living matter in the cartilage were entirely separated.

Dr. Elsberg explained that the blocks were separate, their only connection being the interposed threads of the *reticulum* of living matter, and to the former is due the opalescent character of hyaline cartilage. He further stated that the condition of health of an individual might be inferred in a degree from a study of the character of the

[1] This statement of the general belief is quoted from the introductory paragraph of Thin's memoir "On the Structure of Hyaline Cartilage" (*Quarterly Journal of Microscopical Science*, xvi, 1876) in which Thin's own views are laid down to the effect "that layers of cells epithelial in arrangement exist in the substance of cartilage," "that both the stellate and the parallel systems of lymph-channels exist," etc.

network, a thin section of a very minute portion of the body often showing a difference of network in different persons, *e. g.*, in the thickness of the threads, the size of the meshes, the character of the points of intersection, etc. From the uniformity in the size of the meshes, etc., or from their variability, or from the proportion of corpuscles presenting a normal and abnormal character in their network, a good or bad prognosis was deduced by the physician, and even an indication of the progress of disease.

Prof. E. H. Day remarked on the wonderful character of protoplasm in its wide results in the construction of the most varying textures in the vegetable and animal kingdoms. The speaker's observations have brought the protoplasm of cartilage tissue into correspondence with that in the tissues of the sponge, of the plant, and all the lower forms of life. In protoplasm we are brought face to face with the most astonishing substance in nature.

Mr. J. D. Warner offered objections to the vague views of Virchow on the soul of the cell and its relation to the soul of the individual.

Dr. Newberry said that, having been educated as a physician, and having studied microscopic anatomy under Dr. Charles Robin, he had followed with great interest the progress of modern research into the ultimate structure of organic tissue, and the discussions of the origin and seat of vitality to which it has given rise; and he regarded such investigations as those of Dr. Elsberg as of the highest scientific interest and practical value. If we ever learn the causes of malarial and infectious diseases, or the cure of the morbid growths which are the scourges of humanity, cancer and tubercle, it will be through such researches. But he thought that much of the discussion which had been excited by these investigations had been irrelevant and confusing, especially that in regard to the seat and nature of life, into which microscopists and chemists had entered with great earnestness and some acrimony, but with no satisfactory result. In this discussion some writers had made the ultimate cell the seat of life, and had glorified and almost deified it. Others claimed that the cells were only portions of a general vitalized and automatic tissue; while others still contended that the phenomena of vitality were the mere manifestations of chemical changes taking place in structure otherwise lifeless.

With none of these views could he sympathize as there had really been no approach to an end in the effort to localize or analyze life. Unless we accept the materialistic theory of spontaneous generation advocated by Dr. Bastian, but rejected by most biologists, we must confess that no more is now known of the origin, nature and seat of life than was known to Aristotle. All we have done is to acquire a better knowledge of the *machinery* by which the functions of life are accomplished; most important knowledge truly since it enables us to distinguish between normal and morbid life action in the tissues where this action begins, and promises to point the way for promoting the one, and preventing the other—but limited to the methods in which the life force acts, not reaching the inscrutable and intangible force itself.

The work done by a microscopic cell is wonderful and incomprehensible to us, yet all cells work not as independent individuals, but as members of a community, and for a common end. For example, the terminal cell of the fibril of a plant root is a delicate vesicle—the cell in its simplest form, and yet when new born, and having existed but the fraction of a minute, it begins its special work of supplying certain food elements to the plant above; and this it does with a discrimination which is infallible. Water it absorbs by endosmosis, and when deficient begets progeny to send for it. It also appropriates other things that are necessary to the growth of the plant to which it belongs, whatever that be; if tobacco, an unusual quantity of potash; if grass, of silica. It always works to a pattern determined by the character of the plant whose general economy it serves, and is controlled by the influence which gives to that plant its special and recognizable leaf, flower and fruit, its noxious or alimentary qualities. So in all other parts of the structure the cell is doing its allotted work in a community of which it forms an integral part. It is therefore in no sense an independent individual. Our notions of what constitutes an individual or a community may seem to us quite clear, but they are in fact likely to be somewhat confused. Every man recognizes and asserts his own individuality, but we all know that men who live in communities often think and feel as one though many. A great grief crushes all alike, a great danger rallies all in defence. The social insects, ants and bees, retain their corporeal individuality, but are curiously linked together in a common life that makes each but a part of a whole. A tree is universally accepted as an individual, but as all know it may be divided to form an unlimited number of perfect trees which expand this individual into a forest and prolong its life indefinitely. The sponge is said to be a community of amœboid individuals, but these share a common skeleton, fashioned for the wants of all, and all unite in the general function by which the inhalent and exhalent currents are maintained, a function on which the life of all depends. In the corals which live in communities we find the common skeleton covered with a vitalized gelatinous integument on which are set here and there the individual polyps. These live to a great degree each for itself; each throws out its tentacles and forages for its own support, but at the same time it shares a life with its neighbors; an injury done to one affects those about it, and a misfortune involving a sufficient number destroys the life of the colony.

The elusive and intangible nature of the life which pervades plant tissue is well shown in the growth and decay of a tree. From a microscopic germ a young *Sequoia* springs into existence, and for a thousand years or more lives its life. All this time it is inspired by a power which acts in antagonism to the affinities of inorganic chemistry, in opposition to the force of gravitation, and which builds up a mass hundreds of tons in weight, mostly obtained by the breaking up of one of the strongest bonds in chemistry, that of carbonic acid, appropriating the carbon and setting the oxygen free. Every part of the huge structure is pervaded by this peculiar creative and conservative influence; and every cell of root or stem or leaf contributes its part to the harmonious whole. At length the time arrives when this peculiar influence which we call life deserts the structure it has created. The affinities of inorganic chemistry now assert themselves, all the ephemeral fabric is rapidly disorganized, and soon a heap of ashes—the inorganic matter woven into its composition—alone remains to tell of its existence. Who can tell us what was the nature of the enchantment which created this Aladdin's palace—whence it came, where it dwelt during its sojourn, and whither it has gone? We may say it resided in the terminal root cells; but these are inseparably connected with the leaves hundreds of feet above. The tie that binds them is a vital one; neither could live without the other, nor without the intervening chain which connects them.

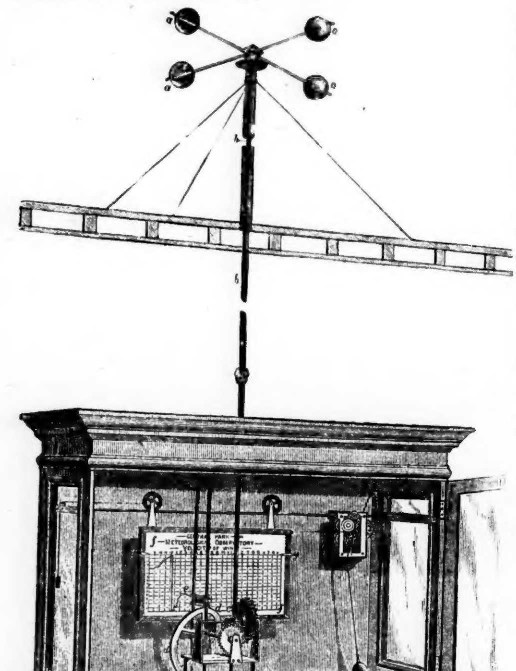
By studying the anatomy of plants and animals, we obtain a knowledge of the organs and laws, as we call them, of animal and plant life; that is, we get a knowledge of the machinery with which the functions of life are accomplished, a knowledge of the order and manner in which these functions are performed; but the *primum mobile*, the real "power behind the throne," remains as yet unseen and unknown to us.

SLIDES OF MARINE ALGÆ.—The Rev. A. B. Hervey, of Taunton, Mass., author of the very beautiful work on "Sea Mosses," will mail to any address for two dollars, a set of six slides showing the characteristic fruit of the six great groups into which Professor Agardh divides the Red Algæ.

DR. D. DRAPER'S INSTRUMENT FOR RECORDING THE VELOCITY OF THE WIND.

On the ends of a cross supported by a vertical shaft several feet above the roof of the building, are four hemispherical copper cups. These, whatever may be the direction of the winds, are caused to turn round with a speed, as has been determined by experiment, of about one-third the velocity of the wind. This portion of the contrivance was the invention of Dr. Robinson, of Ireland. It is used in the foreign observatories, and is known as Robinson's cups.

To the lower end of the shaft thus made to revolve by the cups is attached an endless screw connecting with a train of wheels, which move a cam. The wheels are so arranged that one turn of the cam answers to 15 miles in the movement of the wind. A pencil which rests on the edge of the cam, and bears lightly against a surface, is carried from the bottom to the top of the paper by each revolution of the cam. It should be understood that the paper is attached to a board drawn aside by a clock at the rate of half an inch an hour. The number of times that the pencil moves from the bottom to the top of the paper, multiplied by 15, gives the number of miles that the wind has moved in an hour or day.



The four hemispherical cups, *a a a a*, turned round by the wind, impart their motion to a vertical shaft, *b b*, at the bottom of which is the endless screw, *c*, its lower end resting in a small agate cup filled with oil, connected with the train of wheelwork turning the cam, *d d*. At *e*, is the pencil resting on the edge of the cam; *f f* is a sheet of ruled paper attached to the board, *g g*, by means of small brass clamps, which is drawn aside at the above mentioned rate by the clock, *h*.

STATISTICS OF THE SUN.

The following *Statistics* of the Sun, comprising facts which can be stated in numbers, are selected from Professor C. A. Young's recent work "The Sun," being one of the last additions to Messrs. Appleton's International scientific series.

Solar Parallax (equatorial horizontal), 8.80″ ± 0.02″

Mean distance of the sun from the earth, 92,885,000 miles, 149,480,000 kilometres.

Variation of the distance of the sun from the earth between January and June, 3,100,000 miles, 4,950,000 kilometres.

Linear value of 1″ on the sun's surface, 450.3 miles; 724.7 kilometres.

Mean angular semi-diameter of the sun, 16′ 02.0″ ± 1.0″.

Sun's linear diameter, 866,400 miles; 1,394,300 kilometres. (This may, perhaps, be variable to the extent of several hundred miles.)

Ratio of the sun's diameter to the earth's, 109.3.

Surface of the sun compared with the earth, 11,940.

Volume or cubic contents, of the sun compared with the earth, 1,305,000.

Mass, or quantity of matter, of the sun compared with the earth, 330,000 ± 3000.

Mean density of the sun compared with the earth, 0.253.

Mean density of the sun compared with water, 1.406.

Force of gravity on the sun's surface compared with that on the earth, 27.6.

Distance a body would fall in one second, 444.4 feet; 135.5 metres.

Inclination of the sun's axis to the ecliptic, 7° 15′

Longitude of its ascending node, 74.°

Date when the sun is at node, June 4–5.

Mean time of the sun's rotation (Carrington), 25.38 days.

Time of rotation of the sun's equator, 25 days,

Time of rotation at latitude, 20,° 25.75 days.

Time of rotation at latitude, 30.° 26.5 days.

Time of rotation at latitude, 45,° 27.5 days.

(These last four numbers are somewhat doubtful, the formulæ of various authorities giving results differing by several hours in some cases).

Linear velocity of the sun's rotation at his equator, 2.261 miles per second; 2.028 kilometres per second.

Total quantity of sunlight, 6,300,000,000,000,000,000,000,000,000 candles.

Intensity of the sunlight at the surface of the sun, 190,000 times that of a candle flame; 5300 times that of a metal in a Bessemer converter; 146 times that of a calcium light, 3.4 times that of an electric arc.

Brightness of a point on the sun's limb compared with that of a point near the centre of the disk, 25 per cent.

Heat received per minute from the sun upon a square metre, perpendicularly exposed to the solar radiation at the upper surface of the earth's atmosphere (the solar constant), 25 calories.

Heat-radiation at the surface of the sun, per square metre per minute, 1,117,000 calories.

Thickness of a shell of ice which would be melted from the surface of the sun per minute, 48½ feet; or 14¾ metres.

Mechanical equivalent of the solar radiation at the sun's surface, continuously acting, 109,000 horse-power per square metre; 10,000 (nearly) per square foot.

Effective temperature of the solar surface (according to Rosetti), about 10,000° Cent.; or 18,000° Fahr.

We have to thank our English contemporary the London "*Lancet*" for its acknowledgement of the interesting nature of the articles published in "Science."

The Governor of Texas has taken steps to form a permanent organization preparatory to the establishment of a State University.

FRENCH ACADEMY OF SCIENCES.

Nov. 7, 1881.

Action of cold on the voltaic arc.—According to M. D. Tommasi, the voltaic arc is considerably enfeebled if, by means of a current of water, the electrodes between which it is produced, are cooled. Its brilliancy is then not intense and the least breath extinguishes it. Its temperature also is relatively but little elevated. These facts are evident *à priori*. The magnet displaces and extinguishes it. It is the same on the approach of an inflamable body.

Molecular Physics.—M. Fizeau sent a communication relative to the variation in length of a bar of zinc brought to an even temperature after having undergone different actions. The application which these facts will receive is immediately seen in point of view of the construction of metallic measures.

The accents of the deaf and dumb.—It is known that the deaf and dumb can be taught to speak so that we can converse with them very nearly as well as with men who have possession of both of these senses. M. Félix Hément announces the fact that the individuals who can thus speak, are affected by the particular accent of their native province. As they have not acquired this accent by imitation, since they are deaf, the author thinks that the reason must be sought in the arrangement of the phonetic apparatus, special to each race.

Mechanics.—It is in a special way that M. Bertrand announces a memoire by M. Lévy, relative to the transportation of force to a distance by electricity. It is known that calculus demonstrates that a 16 horse-power engine can transmit force to a distance of 10 to 50 kilometres. M. Lévy states that a much superior result can be obtained.

INFECTED PORK.

It is not only Trichinæ which is to be dreaded in the hams exported by the United States; in one of the recent meetings of the Medical Congress, Dr. E. Ballard and Mr. E. Klein called the attention of the public to another still more dangerous parasite in the same meat. The *Journal of Hygiene* makes the following remarks on this subject:

In 1880, on the estates of the Duke of Portland, at Welbeck, twenty persons were taken seriously ill, after a dinner in which boiled ham had been served, with pork imported from America. Four persons died; others felt no evil effect. The morbid symptoms showed nothing very characteristic (choleric diarrhœa, vomiting, pains in the muscles, great prostration); the autopsy only revealed pulmonary congestion. In a piece of kidney, examined under the microscope, there were found traces of inflammation of the parenchyma, and in the capillaries of the Malpighian tufts, incrustations formed by masses of Bacilli.

In passing over the field of the microscope, particles of the raw ham and of the boiled ham which was infected, a species of Bacillus with its spores was found; the bacillian threads and the spores adhered closely to the muscular fibres and to the intermuscular tissue.

Experiments were made on animals: 1. By feeding and by inoculation, or by the two methods combined. 2. By inoculation after cultivation of the bacillary matter in the incubator. In every case sickness was caused, and at the autopsy, lesions of pneumonia or pulmonary hemorrhage were established.

A second series of observations was made on fifteen persons who felt serious symptoms after having eaten a leg of pork, roasted in the oven, bought at a second-class cookshop. One of them having died, Bacilli were found, at the autopsy, in the blood of the heart, in the blood pressed out of the pulmonary tissue, and in the blood extravasated around the pulmonary alveoli. The tissues of the stomach, the ileum, the spleen, and the kidneys, also contained Bacilli.

Experiment by inoculation with different liquids, on animals, caused morbid and often mortal symptoms. Bacilli were also found in the blood, and in the different tissues of the animals. Unfortunately, in this case, the suspected food could not be examined.

In the face of these facts, Messrs. Ballard and Klein do not hesitate to admit an acute specific affection, not to this day defined, and presenting marked characteristics, in point of view of the morbid phenomena, with the known cases of poisoning by damaged or trichinated meat.

Dr. Tripe, of London, recalled two febrile maladies which he had observed in his medical circumscription. In the first, sixty-six persons showed alarming morbid symptoms, after a dinner in which sausage containing a mixture of beef and pork fat, had been served. In the second it was pork fat alone which was the immediate cause of the sickness. Dr. Buchanan mentions cases of diseases, in which beef and mutton constituted the infected substances.—*La Nature.*

THE COMPARATIVE ACTION OF DRY HEAT AND SULPHUROUS ACID UPON PUTREFACTIVE BACTERIA.*

Pieces of woolen and cotton cloths and wadding were dipped in a solution of putrefying flesh and slightly dried; and after being shown to be infected by causing discoloration and development of bacteria in a Pateur solution, one portion was subjected to dry heat, and the other to the influence of a definite quantity of sulphurous acid. When these agents had operated for a certain time, the substances were brought into a developing liquid and again observed.

These experiments, which were conducted by Dr. Wermch, were as follows:

First. Fragments of the materials above referred to, treated as mentioned and dried, produced in sixteen experiments an exceptionably rapid disturbance of the test liquid. In four experiments with wadding this was somewhat retarded. It took place most rapidly in tubes which had been inoculated with woolen thread.

Second. After inoculation with the material which had been exposed one or two minutes to a dry heat of 284° to 300° F., clouding took place in four of eight experiments; but only after from two to three days. With material which had been exposed from ten to sixty minutes to a a heat of 230°–244° F., in five out of six experiments a development of bacteria took place after the end of twenty-four hours.

Third. Substances which were exposed five minutes to a heat of 257° to 302° F. produced no infection whatever in ten experiments. The test liquid remained clear for eleven days from the time of inoculation.

Fourth. When the objects were exposed under a bell glass to the action of a percentage, by volume, of 1.5, 2.2, and 3.3 of sulphurous acid, in eight out of nine experiments a bacterial clouding was developed in the sulphurized material, whether the application had continued for one hour or twenty-two.

Fifth. In fifteen experiments, in which sulphurous acid constituted 4.6 and 7.15 per cent. by volume, of the contents of the bell glass, the introduction of the sulphurized material produced no cloudiness, when the experiment continued six hours and more. On the other hand an exposure of 20, 40, 60, and 200 minutes was followed by the development of bacteria.

In conclusion, the fact was considered especially interesting that the different fabrics gave up the infection concealed in them with different degrees of rapidity, the woolen fiber the quickest, the linen less easily, and the wadding with the greatest difficulty of all.

* From the proceedings of United States National Museum.

NOTES ON THE MORTALITY AMONG FISHES OF THE GULF OF MEXICO.

Prof. SPENCER F. BAIRD, *U. S. Commissioner of Fish and Fisheries, Washington, D, C.:*

SIR: Noticing in the Forest and Stream of 9th instant some answers to queries as to the cause of mortality among fishes in the Gulf of Mexico, I make bold to present the result of my observations.

After very heavy rains and overflowing of rivers, the inner bays on the Texas coast suffer a loss of from one-half to three-fourths of their stock of salt water fish, not including mullet, which live as well in fresh as salt water. In fact land-locked mullet in a fresh water pond or tank grow to a weight of nine or ten pounds.

Last winter, after a heavy rain and a freeze, *all* the salt water fish in the *Laguna del Madre* (a large sheet of water lying between Padre Island and the mainland) were found dead on the banks.

We have two causes for the destruction of fish here, vis., too much fresh water and too cold weather.

In the lagoon above spoken of, in a long drought, the water gets too salty for the fish, and they become covered with sores, and unless relieved by a rain they die from too much salt.

I have never known any serious mortality among fish on the Gulf coast where there was a free flow of water, except during violent storms, when many fish both small and large were beached and killed.

Very respectfully,
S. H. JOHNSON.

CORPUS CHRISTI, Texas, *June* 17, 1881.

ANGLO-AMERICAN ARCTIC EXPEDITION.

Commander Cheyne's paper, describing his proposed Arctic expedition in conjunction with Lieut. Schwatka, read before the N. Y. Academy of Sciences, on the 28th ultimo, will be printed in our next issue, with the regular proceedings of the Academy. We understand that Commander Cheyne is receiving a strong support from those interested in the subject, and that there is an early prospect of his plans taking a definite form.

The English Arctic Council for the organization of this expedition, meet on the 13th instant, and are awaiting a cablegram, informing them of the prospects of success, for international co-operation.

ADVICE TO ASTRONOMERS.—In Sir William Herschel's work "*On the Construction of the Heavens*," the following line of conduct for astronomers is indicated: "in an investigation of this delicate nature we ought to avoid two opposite extremes. If we indulge a fanciful imagination and build worlds of our own, we must not wonder at our going wide from the path of truth and nature. On the other hand, if we add observation to observation, without attempting to draw not only certain conclusions but also conjectural views from them, we offend against the very end for which only observations ought to be made. I will endeavor to keep a proper medium, but if I should deviate from that I could trust not to fall into the latter error.—*See Holden's and Hasting's Synopsis.*

METEOROLOGICAL REPORT FOR NEW YORK CITY FOR THE WEEK ENDING DEC. 3, 1881.

Latitude 40° 45′ 58″ N.; Longitude 73° 57′ 58″ W.; height of instruments above the ground, 53 feet; above the sea, 97 feet; by self-recording instruments.

NOVEMBER AND DECEMBER.	BAROMETER. Mean for the day. Reduced to Freezing.	Maximum. Reduced to Freezing.	Maximum. Time.	Minimum. Reduced to Freezing.	Minimum. Time.	THERMOMETERS. Mean. Dry Bulb.	Mean. Wet Bulb.	Maximum. Dry Bulb.	Time.	Maximum. Wet Bulb.	Time.	Minimum. Dry Bulb.	Time.	Minimum. Wet Bulb.	Time.	Maxi'm In Sun
Sunday, 27	29.939	30.016	7 a. m.	29.848	6 p. m.	43.0	38.3	50	4 p. m.	43	7 p. m.	35	7 a. m.	33	7 a. m.	103.
Monday, 28	30.345	30.398	9 p. m.	29.976	0 a. m.	30.0	27.3	48	0 a. m.	43	0 a. m.	27	9 a. m.	25	9 a. m.	96.
Tuesday, 29	30.204	30.374	0 a. m.	30.098	12 p. m.	40.0	36.6	49	4 p. m.	45	7 p. m.	28	6 a. m.	27	6 a. m.	95.
Wednesday, 30	30.026	30.098	0 a. m.	29.908	12 p. m.	47.0	44.7	54	3 p. m.	49	3 p. m.	37	9 a. m.	37	9 a. m.	103.
Thursday, 1	29.754	30.082	12 p. m.	29.518	1 p. m.	49.3	47.3	56	4 p. m.	52	12 m.	43	12 p. m.	40	12 p. m.	69.
Friday, 2	30.284	30.306	9 a. m.	30.082	0 a. m.	39.3	35.7	44	3 p. m.	40	0 a. m.	36	7 a. m.	34	7 a. m.	104.
Saturday, 3	30.131	30.272	0 a. m.	30.088	6 p. m.	38.0	36.0	40	3 p. m.	38	3 p. m.	35	5 a. m.	33	5 a. m.	76.

Mean for the week .... 30.097 inches.
Maximum for the week at 9 p. m., Nov. 28th .... 30.398 "
Minimum " at 1 p. m., Dec. 1st .... 29.518 "
Range .... .880 "

	Dry.		Wet.
Mean for the week	40.9 degrees		37.9 degrees.
Maximum for the week, at 4 pm., Dec. 1st	56. "	at 12 m 1st,	52. "
Minimum " " 9 am., Nov. 28th	27. "	at 9 am 28th,	25. "
Range " "	29. "		27. "

NOVEMBER AND DECEMBER.	WIND. Direction. 7 a. m.	2 p. m.	9 p. m.	Velocity in miles. Distance for the Day.	Force in lbs. per sqr. feet. Max.	Time.	HYGROMETER. Force of vapor. 7 a. m.	2 p. m.	9 p. m.	Relative humidity. 7 a. m.	2 p. m.	9 p. m.	CLOUDS. Clear, 0 Overcast, 10. 7 a. m.	2 p. m.	9 p. m.	RAIN AND SNOW. Depth of rain and snow in inches. Time of Beginning.	Time of Ending.	Duration. h. m.	Amount of water	OZONE.
Sunday, 27	w. s. w.	w. s. w.	w. s. w.	278	8	1.30 pm	.162	.143	.215	80	42	69	0	4 cir. cu.	8 cu.	-----	-----	----	--	8
Monday, 28	n.	n.	e. s. e.	204	9	0.50 am	.136	.101	.119	88	58	68	0	0	0	-----	-----	----	--	0
Tuesday, 29	n. n. e.	s. w.	w.	31	½	1 30 pm	.124	.179	.241	77	55	83	0	8 cu.	5 cu.	-----	-----	----	--	0
Wednesday, 30	w. s. w.	w. s. w.	s. s. e.	58	⅛	3.00 am	.238	.245	.321	100	65	86	10	2 cir.	10	9.30 pm	12 pm	2.30	.01	0
Thursday, 1	e.	w.	n. w.	184	18½	7.30 pm	.309	.362	.241	85	87	83	10	10	0	0 am	3 pm	15.00	.51	6
Friday, 2	n. w.	n. e.	e.	141	3½	3.00 am	.170	.142	.173	80	51	72	1 cir.	5 cir.	0	-----	-----	-----	--	2
Saturday, 3	e. n. e.	n. n. e.	n. n. e.	138	2½	10.40 am	.149	.203	.207	70	82	90	5 cir. cu.	10	10	8.30 pm	12 pm	3.30	.01	10

Distance traveled during the week .... 1,034 miles.
Maximum force .... 18½ lbs.

Total amount of water for the week .... .53 inch.
Duration of rain .... 21 hours, 00 minutes.

DANIEL DRAPER, Ph. D.
Director Meteorological Observatory of the Department of Public Parks, New York.